Claims

What is claimed is:

1. A method of separating ions comprising the steps of:

providing an analyzer region that is operable in both an rf-only mode and in a FAIMS mode;

introducing ions into the analyzer region;

effecting a selective separation of the ions within the analyzer region substantially during operation in the FAIMS mode; and,

extracting ions from the analyzer region substantially during operation in the rf-only mode.

2. A method according to claim 1, comprising a step prior to the step of effecting a separation of the ions of: trapping some of the introduced ions within the analyzer region by the application of selected electric potentials at the ends of the analyzer region.

3. A method according to any one of claims 1 and 2, comprising a step prior to the step of extracting ions from the analyzer region of: controllably switching the analyzer region from the FAIMS mode to the rf-only mode.

4. A method according to any one of claims 1 to 3, wherein the analyzer region is provided as a space between a set of parallel rods, the space having first and second ends.

5. A method according to any one of claims 1 to 4, wherein the ions are introduced into the analyzer region substantially during operation of the analyzer region in the rf-only mode.

6. A method according to claim 5, comprising a step prior to the step of selectively separating ions of: controllably switching the analyzer region from the rf-only mode to the FAIMS mode.

7. A method according to claim 6, comprising a step prior to the step of controllably switching the analyzer region from the rf-only mode to the FAIMS mode of: collisionally cooling the ions so as to confine the ions within a volume that is smaller than a volume occupied by the ions prior to collisional cooling.

8. A method according to any one of claims 1 to 4, wherein the ions are introduced into the analyzer region substantially during operation of the analyzer region in the FAIMS mode.

9. A method according to any one of claims 1 to 8, comprising a step prior to the step of extracting ions of: collisionally cooling the selectively separated ions.

10. A method according to claim 9, comprising a step prior to the step of extracting ion of: controllably switching the analyzer region from the rf-only mode to the FAIMS mode, so as to effect a selective second separation of the collisionally cooled selectively separated ions.

11. A method according to claim 2, wherein the step of extracting ions includes a step of applying a different selected electric potential at the second end of the analyzer region.

12. A method according to any one of claims 1 to 11, comprising a step of providing the extracted ions to one of a detector, an analyzer and an ion collector.

13. A method according to claim 7, comprising a step after the step of extracting ions of: refilling the analyzer region with ions while the analyzer region is operating in the rf-only mode.

14. A method according to claim 4, wherein the set of parallel rods has a quadrupole configuration.

15. A method according to claim 14, wherein each parallel rod of the set of parallel rods includes a plurality of coaxially aligned segments.

16. A method according to claim 15, wherein ions are extracted from the analyzer region as a result of an electric field established within the analyzer region by application of different dc voltages between different sets of segments of the parallel rods.

17. A method according to any one of claims 1 to 16, wherein the gas pressure in the analyzer region is in the range between 10^2 torr to 10^{-6} torr.

18. A method according to any one of claims 1 to 17, wherein the gas pressure in the analyzer region is in the range between 10 torr to 10^{-4} torr.

19. A method according to any one of claims 1 to 18, wherein the gas pressure in the analyzer region is in the range between 5 torr to 10^{-2} torr.

20. An apparatus for separating ions comprising:

a set of parallel rods having a space therebetween, the space having first and second ends and defining an analyzer region; and,

an electrical controller for electrically coupling to the set of parallel rods, for applying at least an rf-voltage between the parallel rods of the set of parallel rods in a first operating mode and for applying a combination of an asymmetric waveform voltage and a direct current voltage between the parallel rods of the set of parallel rods in a second operating mode.

21. An apparatus according to claim 20, comprising trapping members disposed proximate the first and second ends of the space for providing a stopping voltage, the stopping voltage for cooperating with the rf-voltage in the first operating mode and for cooperating with the combination of an asymmetric waveform voltage and a direct current voltage in the second operating mode to constrain ions within the space between the first and second ends.

22. An apparatus according to any one of claims 20 and 21, wherein the set of parallel rods has a quadrupole configuration.

23. An apparatus according to any one of claims 20 to 22, wherein each parallel rod of the set of parallel rod comprises a plurality of coaxially aligned segments in an end-to-end arrangement.

24. An apparatus according to claim 23, comprising an electrically insulating member disposed between adjacent segments of the coaxially aligned segments within a same parallel rod.

25. An apparatus according to any one of claims 20 to 24, wherein the trapping members comprise an ion entrance lens disposed adjacent the first end of the space and an ion exit lens disposed adjacent the second end of the space.

26. An apparatus according to any one of claims 20 to 21, wherein the set of parallel rods includes six parallel rods.

27. An apparatus according to any one of claims 20 to 21, wherein the set of parallel rods includes eight parallel rods.

28. An apparatus according to any one of claims 20 to 27, comprising a housing for containing the set of parallel rods and for maintaining a predetermined atmosphere including a bath gas within the analyzer region.